Whole-Body Vibration: What can we do to reduce this known health risk?

IWH Ergonomics/MSD plenary

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Western University

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What is Whole-body Vibration?
Why Whole-body Vibration?
Why Whole-body Vibration?

- Strong association between LBP and WBV (Bernard, 1997 - NIOSH)
- Dose-response relationship between WBV and driving-related LBP (Tiemessen et al., 2008)
- Between 4% and 7% of the work force in North America and Europe is exposed to potentially harmful levels of whole-body vibration (Bovenzi, 1996; Wasserman et al., 1997)
Mechanism: LBP and Injury Whole-body Vibration?

www.spinespecialtyinstitute.com/spineinstitute/images/ddd1.jpg
How (to measure) Whole-body Vibration?

International Standards: ISO 2631-1

Tri-axial accelerometer mounted in rubber seat pad

Seat pad positioned on vehicle seat

Accelerometer on the floor below the seat

Data-logger used to record the vibration data collected in the field

WBV & Optimized Seating
How (to evaluate) Whole-body Vibration?

International Standards: ISO 2631-1

\[
A_w = \left[ \frac{1}{T} \int_0^T a_w^2(t) \, dt \right]^{\frac{1}{2}}
\]

**Average**

**Impulsive**

\[
VDV = \left\{ \int_0^T [a_w(t)]^4 \, dt \right\}^{\frac{1}{4}}
\]

<table>
<thead>
<tr>
<th>8 hrs of Exposure</th>
<th>Aw (m/s^2)</th>
<th>VDV (m/s^{1.75})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
<td>0.45</td>
<td>8.5</td>
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<tr>
<td>Limit</td>
<td>0.9</td>
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</table>
How to Reduce Whole-body Vibration?

- Vehicle Speed
- Road Maintenance
- Seating
Magnitude at 2.2 hz = 1.28
Crossover = 2.94 hz

Wegscheid Journal of Forest Engineering 5(2)21-32, 1994
First Approach: Laboratory Testing
Figure 11 – Transfer functions in the Z-axis for the Access seats (new, used, and old condition). The transfer function for the old condition seat has a higher peak in transmissibility at a lower frequency than the new and used condition seats, and the transmissibility drops more quickly at a lower frequency.
A(8) HGCZ 0.45-0.9 m/s²

<table>
<thead>
<tr>
<th>Skidders</th>
<th>A(8) (m/s²)</th>
<th>Access</th>
<th>Amobi</th>
<th>CAT</th>
<th>KAB301</th>
<th>KAB525</th>
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<td>S1</td>
<td>0.76</td>
<td>0.9</td>
<td>0.61</td>
<td>0.75</td>
<td>0.83</td>
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<td>S2</td>
<td>0.76</td>
<td>0.86</td>
<td>0.63</td>
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<td>S3</td>
<td>0.75</td>
<td>0.89</td>
<td>0.74</td>
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<tr>
<td>S4</td>
<td>1.3</td>
<td>1.54</td>
<td>0.9</td>
<td>1.32</td>
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<tr>
<td>S5</td>
<td>1.07</td>
<td>1.24</td>
<td>0.79</td>
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<tr>
<td>S6</td>
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<td>1.21</td>
<td>0.62</td>
<td>1.02</td>
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<td>0.69</td>
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<th>Amobi</th>
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<th>KAB525</th>
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<td>1.04</td>
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<tr>
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</table>

Second Approach: Field Testing

Also in steel making industry:

Seatpan Accelerations:
iPod and WBV App:
iPod and WBV App:

**Graph 1:**
- **View Data**
- **Select Data**
- **Raw**
- **Filtered**
- **X**
- **Y**
- **Z**

**Graph 2:**
- **Trials**
- **30072**
- **VDV**
- **VDV(8)**
- **RMS**
- **Exposure Duration** 8 hours
- **RMS (m/s²)**: X: 0.60, Y: 0.29, Z: 0.77
- **Time to HGCZ (h)**: X: 5.48, Y: 23.46, Z: 3.41
- **VDV (m/s^1.75)**: X: 5.89, Y: 2.83, Z: 7.54
- **VDV(8) (m/s^1.75)**: X: 11.72, Y: 5.64, Z: 15.00
- **Trial Duration**: 0h 31m 26s
- **Equipment**: Water Truck
- **Task**: Watering

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**Western**

Dr Jim Dickey

WBV & Optimized Seating
Instrumentation:

- 90 Hz vibration
- 5 Hz GPS

Dr Jim Dickey
WBV & Optimized Seating
Standard Driving Route:
Analysis:
Results:

![Graph showing acceleration data for different seating positions and durations.]

- **A(8)-4.5 hr driver**
- **A(8)-4.5 hr passenger**
• 8-15% reductions
• **Reductions in y-axis too
Conclusions:

- Seating can reduce vibration exposure
- Seat selection is not straightforward
- WBV App is a powerful assessment tool that is likely suitable for screening
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References:


